

Regulatory Strategy for Renewable Energy Integration

Jun Liu^{*1}, Ting Zhang², Hui Xu³, Yongxiu He⁴

^{*1,2,4}School of Economics and Management, North China Electric Power University, Beijing, 102206, China,

^{*1,3}Gansu Electric Power Corporation, Lanzhou, 730050, China

^{*1}692555169@qq.com; ²zhangting1151@126.com; ³zhangting2206133@163.com; ⁴bingw1130@126.com

Abstract

This paper has made a comparison on typical countries' RE policies, and explored the trends of renewable energy, finally the regulatory strategy of renewable energy integration has been put forward, which can be adapted to China.

Keywords

Renewable Energy Integration; Electricity Regulatory Strategy

Introduction

In recent years, under the guidance of relevant policies, renewable energy (RE) power generation in China has increased significantly. At the end of 2012 in China, the installed capacity of wind power and solar power respectively reached 60.83 MW and 328 MW. While the grid-connected and solar wind power generation separately reached 1004 kWh and 35 kWh, which respectively increased by 35.5% and 414.4 % compared to power generation at the level of last year ^[1]. The technical and economic characteristics of RE, such as wind power, solar powers and so on, are much different from the thermal power. Thus, to some extent, the connection of large-scale RE power to the grid will change the operation mechanism of the electricity market, and as a result, the supply and demand of electricity market and the return of the market will be significantly impacted. Therefore, the connection of large-scale RE power to the grid and its sustainable development cannot be separated from the role of electricity regulation. With the further reform in the electricity market, an efficient regulatory system of renewable energy integration is urgently needed to be established. This paper has made a comparison on typical countries' RE policies, and explored the trends of RE power, finally the regulatory strategy of renewable energy integration has been put forward, which can be adapted to China.

Typical Countries' Regulatory Strategy Status of Renewable Energy Integration

The United States

As a model of "regulated capitalism", the development of the power industry regulatory regime in the United States strictly followed the principle of the legislation at first. The way the U.S. federal government supervises the power industry is based on the trade provisions of the Constitution of the United States which regulates that the federal government for electricity supervision of the industry is focused on the interstate power trading activities, and making the activities within the state to the state government to supervise. The Federal Power Act, the Public Utilities Regulatory Policy Act and the Energy Policy Act constitute the legislative basis for the federal government to participate in interstate commerce regulation of the electricity. The electricity regulatory agencies in the United States are considerably independence and divided into federal and state regulatory agencies.

The electricity regulation is mainly relied on state management; while the Federal Energy Commission only proposes requirements such as the separation of the power plant and power grids as well as the introduction of competition mechanism and so on. The specific programs of electricity reform are carried out by the states according to their own actual situation. The United States has set up the ISO market monitoring agency whose main functions include: collection and collation of the market operation data; monitoring market participants to comply with the rules of the market; tracking and assessing the market situation and submitting market analysis reports; examining the market potential defects and the proposal of improvements; as well as the implementation of necessary investigations on non-normal market performance or the adoption of

appropriate corrective measures on violations within the authority [3].

The United States has always implemented policies beneficial to save energy and develop RE, which can be summarized as four aspects, that is, regulatory policies, fiscal incentives policies, voluntary measures and technology policies.

TABLE 1 THE POLICIES OF RENEWABLE ENERGY INTEGRATION IN THE UNITED STATES

Project	Content
Regulatory policies	Mainly include the policy, a mandatory demanding, that the RE generation occupies a certain proportion of the total generating capacity; the policy requiring the government agencies to use green energy. For example, in the revised plan in 2002, California required that the green power ratio three largest electricity producers offered should reach 20% in 2017.
Fiscal incentives policies	Mainly include direct subsidies to green power projects, tax incentives and low-interest or interest-free loans and so on.
Voluntary measures	Mainly include the policy of green electricity certificates; the projects that make the RE technologies market-oriented; as well as a variety of educational outreach projects in order to deepen the residents' understanding and recognition to green electricity.
Technology policies	Mainly include the development of wind power technologies, carbon capture and sequestration technologies, smart grid construction and so on.

Australia

The electricity regulations in Australia are very condensed; in which the Trade Practices Act plays a significant role, while the State Electricity Ordinance is supplementary. The Trade Practices Act is authorized to establish the Australian electricity regulatory agencies-the Australian Consumer and Competition Commission (ACCC). First of all, the Trade Practices Act clearly points out the functions and powers of the ACCC, and the decision-making process of ACCC members is also clearly stated in the law to avoid being modified easily or subjected to political intervention; Secondly, the Trade Practices Act contains many contents that refer to anti-competitive behavior; Finally, the trade Practices Act provides punitive measures for the ACCC in case that it may violate the law to ensure the ACCC to comply with the legal requirements.

80% of Australia's total electricity supply is from thermal power generation with coal as raw material. In order to increase the proportion of RE power in the energy consumption structure, Australia's policies on

renewable energy integration are mainly reflected in the four links, that is, the power generation link, the power transmission link, the power distribution link and the power consumption link; which are specifically shown in table 2.

TABLE 2 THE POLICIES OF RENEWABLE ENERGY INTEGRATION IN AUSTRALIA

Project	Typical Measures
The power generation link	Mainly includes measures on the set of mandatory proportion of RE generation by Renewable Energy (Electricity) Act; financial support for RE power generation projects (such as tax breaks, subsidies, low-interest loans, etc.); implementation of mandatory feed-in tariff system for RE power.
The power transmission and distribution link	100 million had been invested in the implementation of smart grid construction.
The power consumption link	Mainly include measures of providing subsidies to encourage the use of green electricity; as well as distributed energy such as solar power; and so on.

The United Kingdom

In 1989, the United Kingdom determined the new institutional framework system of Power Industry management, and set up an independent regulatory organization-the Office for Electricity Regulation (OFFER, is later renamed as the Office of Gas and the Electricity Market, Ofgem) to strengthen the electricity supervision taking responsibilities on two aspects: one is to prevent the natural monopoly enterprises from abusing monopoly power by means of the implementation of price-cap policy on the monopoly enterprises; the other one is to take appropriate regulatory measures to promote competition between electricity production and supply enterprises. After reform, the electricity regulatory mechanism has achieved the separation between government and enterprises, and the separation between government and electricity regulator. In 1999 the new regulatory institutions-OFGEM was established which was responsible for the implementation of competition among power producers and competition among power consumers. The equal emphasis on the independent regulation and the checks and balances mechanisms is the main feature of the Electricity Regulatory system reform in the United Kingdom.

Britain's policies for renewable energy integration mainly reflected in the capital management for RE, the access of RE to the grid and the price management and

the fiscal subsidies policy, are shown in table 3:

TABLE 3 THE POLICIES OF RENEWABLE ENERGY INTEGRATION IN THE UNITED KINGDOM

Project	Content
The capital management for RE	Mainly include policy of the establishment of Green investment bank and an executive committee to raise funds for RE projects.
The access of RE to the grid and the price management	The system of "the access of RE to the grid and management" was launched in 2010 to confirm that the RE have the priority to access to the grid; at same time a strong market signal for investors is given to encourage investment in RE generation to ultimately increase the market competitiveness on the RE power price.
The fiscal subsidies policy	Mainly include policy of the tax system, the Carbon Trust Fund and other government subsidy mechanism to ensure the implementation of the sustainable development of the RE.

Regulatory Strategy Status of Renewable Energy Integration in China

The electricity regulatory agencies in China is the State Electricity Regulatory Commission (SERC) established in 2003 and directly affiliated to the State Council having the branches of six regional and 12 provincial dispatched institutions. In 2013, the SERC and the former State Bureau of Energy were merged and the new National Energy Board was established.

There is a complete laws and regulations system for electricity regulation in China. China's legal construction for electricity has started from 1980s (The Electricity Law was drafted in 1986), and has formed the legal framework which treats the law as the core, the administrative regulations as the supplement and the departmental rules as the support. The specific content is shown in the table 4:

TABLE 4 THE MAIN LAWS, ADMINISTRATIVE REGULATIONS AND THE DEPARTMENTAL RULES FOR ELECTRICITY REGULATION IN CHINA

Category	Name
The laws	"Electricity Act of the People's Republic of China" (1996), "Circular Economy Act of the People's Republic of China" (2009), "Renewable Energy Act of People's Republic of China" (2006)
The administrative regulations	"Electricity supply and use Ordinance" (1996), "Grid Scheduling Management Ordinance" (1993), "Power Facilities Protection Ordinance" (1987), "Electricity Regulatory Ordinance" (2005), etc.
The departmental rules	"Power Supply Rules" (1996), "Power Supply Zoning and Management Rules" (1996), "Electricity Market Regulatory Rules" (2005), "Electrician Permit Management Rules" (2006)

There are some articles on the regulation of grid-connected RE in the "Renewable Energy Act of People's Republic of China". The specific content is

shown in the table 5:

TABLE 5 THE ARTICLES FOR THE REGULATION OF GRID-CONNECTED RE IN THE "RENEWABLE ENERGY ACT OF PEOPLE'S REPUBLIC OF CHINA"

Articles	Content
Article 8	The Electricity Regulatory agencies and the Energy department of the State Council in charge of the preparation of the development and utilization planning for the national renewable energy should put the development and utilization planning for the local renewable energy on record.
Article 14	The Electricity Regulatory agencies and the Energy department of the State Council in charge of determining the proportion of RE power generation and formulating the specific measures that give the dispatching priority to RE should make all the RE power get access to the grid.
Article 27	The Electricity Regulatory agencies have the right to inspect and supervise the power enterprises.
Article 29	The Electricity Regulatory agencies have the right to execute the corresponding administrative punishment. For the power enterprises failing to complete the acquisition of RE power and result in the economic losses of RE power producer, the Electricity Regulatory agencies have the right to demand them to make corrections and impose a fine that is not more than double economic losses of the RE power producer.

The Regulatory Trends of Renewable Energy Integration

The Settings and Properties of the Electricity Regulatory Agencies

At present, the regulatory agencies can be divided into three categories: the first is that the regulatory agencies are the internal department of the ministries and commissions; the second is that the regulatory agencies are semi-independent from the ministries and commissions. In this pattern, the regulatory agencies have independent decision-making powers under the law, but not complete independent due to the fact that the institutional settings are part of the subsidiary of the ministries and commissions or the heads of the regulatory agencies appointed by the Minister; the third is that the regulatory agencies are completely independent from the ministries and commissions. These agencies have independent decision-making powers and are completely independent from the ministries and commissions.

The electricity regulatory pattern in United States, Australia and other countries belongs to the third category. Because the regulatory agencies are independent of the government, they are with strong authority and neutrality. Currently, the electricity

regulatory in China is incapable to avoid government regulation and the regulatory agencies in China belong to the first category. But with the acceleration of the electricity market reform, the responsibilities of electricity regulatory agencies will be gradually clear.

The Regulatory Functions

With the gradual improvement on the electricity market, the general trends of all the national electricity regulatory reform is to distinguish the competitive aspects (including the power generation link and the power consumption link) and the monopoly aspects (including the power transmission link and power distribution link). The policy will be to loosen the economic regulation on the competitive aspects and to enhance the power regulation on the natural monopoly aspects which include the regulation of power access, price, safety, environmental protection, universal service and other non-economic regulatory content (i.e. the social regulation).

The economic regulation on competition aspects no longer focuses on strict access and price controls. The regulatory aim is to encourage fair competition and prevent market monopoly. The specific regulatory content includes the power access, the ownership structure, environmental protection, and the service quality.

The economic regulation on monopoly aspects focuses on transmission and distribution price and the power access. Social regulation mainly involves technology, safety, consumer interests, the development of clean energy, pollutant emissions, environmental protection, universal service and other aspects.

Because of the gap between the developed and developing countries, their electricity reform target is very different. In the preconditions that the electricity market is mature and the power supply is greater than the demand, the focus of reform in developed countries is the incentive regulation of the price. While as the developing countries confronts the task to promote economy and realize the social development goals, their electricity reform focus on the guarantee of the security operation of the power system, attracting new investment and, in particular, promotion of investment in renewable energy integration such as smart grid construction investment.

The Regulatory Balance Mechanism

The foreign regulatory balance mechanism is

composed of four aspects: the first is the separation policy between government and regulation. Government departments are responsible for the formulation of policies and plans while the regulatory agencies are in charge of its implementation. The second is the policy authorized by laws. The settings and properties of the electricity regulatory agencies are formulated by the law in order to avoid the abuse of rights. The third is to realize transparency, which mainly includes: the implementation of a clear picture of the role of regulators; popularization of its decision-making mechanisms; development of clear regulatory rules and procedures of arbitration disputes; announcement of the decision and its reasons and so on. The fourth is the mechanism of dispute settlement. In general, there are two types which are arbitration and judicial power.

In summary, the modern electricity regulatory mechanism has the following characteristics: independence; separation from the political management; economic deregulation, the strengthening of monopolistic link and the social supervision, as well as legal authorization and supervision based on the law; the effective supervision and the regulatory balance mechanism.

The Regulatory Strategy for Renewable Energy Integration in China

Learning the International Experience of Legislation First

China should learn from international experience to strengthen the power legal system. Specific rules should be developed for electricity regulation under the effort of the related government departments. The contents of the rules should cover: the status of the electricity regulatory agencies, the code of conduct, the functions, the principle of tariff regulation, the quality of service, the arbitration mechanism and so on.

For the supervision of renewable energy integration, in 2006 China introduced "Renewable Energy Act" (it was modified in 2009) which ensures the priority of RE in the grid and gives the regulatory rights to the relevant departments. With the development of China's RE, the principle of the legislation, first of all, should be followed. The "Renewable Energy Law" and other relevant laws and regulations should be further improved to promote the development of RE power.

Gradually Setting Independent Regulatory Agencies and Clarifying Their Functions

Gradually setting independent regulatory agencies is the fundamental way to solve the current situation that electricity supervision can't be separated from government regulation and that the regulatory functions is vague. It is also key to determine whether the modern electricity regulatory system is fair, transparent, and professional.

In 2013, China reformed electricity regulatory industry. The State Electricity Regulatory Commission (SERC) and the original National Energy Administration were merged into a new National Energy Administration (NEA). Thus, the SERC was reduced from the department directly under the State Council to the department under the NEA. On the one hand, it reflects the improvement of the situation that electricity supervision is mixed with the government regulation. The functions of the SERC are clearer. It is the first step of the development of modern electricity regulatory system in China; on the other hand, it also reflects that the supervision of RE power will be an important part of the SERC.

The Establishment of the Incentive Price Regulation Mechanism

According to the new theory of regulatory economics, there is a game between the regulatory agencies and the regulated firms due to the information asymmetry between them. Correspondingly, the price ceiling regulation is a new regulation tool which adds a price-cap on the transmission and distribution price under the premise of the price index in consideration. The price ceiling is periodically adjusted (Usually it is gradually reduced). The regulatory agencies formulate a price ceiling of the next phase in advance and request the transmission and distribution price of the regulated firms to be lower than the price ceiling within the rule time, resulting in an incentives mechanism that can help the regulated firms improve efficiency and reduce costs. Therefore, it is called the incentive price regulation mechanism. Addition to the price ceiling regulation mechanism, there are other incentive regulation schemes which are the concession competition mechanism and yardstick competition mechanism. By introduction of profit incentives or competitive stimulation into the regulated firms, these incentive regulations can help to cut costs and improve the efficiency of resource allocation.

The price regulation, a dynamic process, has difficulty in direct control. The incentive price regulation mechanism useful for the price control of renewable energy integration as well; can be a reference in the construction of the regulatory regime for renewable energy integration. The measures of the incentive price regulation mechanism on renewable energy integration include: promising the subsidies provided for the power transmission, dredging the high price to all the links of the RE tariff, encouraging the grid companies to accept the RE power and so on.

Conclusions

One way to establish the modern electricity regulatory system is to fully learn from the advantage of international advanced experience and to gradually improve and perfect our regulatory system. The conclusions include the following points:

- (1) The first is to adhere to the principles of the legislation at first and to improve China's the legal system to provide legal protection for renewable energy integration. The "Renewable Energy Law of China" and other relevant laws as well as regulations should be further improved to promote the development of RE power. The contents of the rules should include: the status of the electricity regulatory agencies, the Code of Conduct, the functions, the principle of tariff regulation, the quality of service, the arbitration mechanism and so on.
- (2) The second is to gradually define the functions of the RE power regulatory agencies, including its regulatory content and related regulations and measures, to make the electricity regulations more market-oriented and to lay the foundation for the establishment of modern electricity regulatory agencies.
- (3) To construct modern electricity regulatory system different from the traditional political regulatory system is a way to improve the regulatory efficiency and make large-scale RE power get access to the grid. The modern electricity regulatory mechanism has the following characteristics: independence; separation from the political management; economic deregulation, the strengthening monopolistic link and the social supervision, legal authorization and supervision based on the law; the effective supervision and the regulatory balance mechanism.
- (4) The fourth is to establish an incentive price regulation mechanism for renewable energy

integration, to periodically adjust the price cap according to the actual situation and to establish a dynamic tariff regulation on RE power. The measures include: promising the subsidies provided for the power transmission, dredging the high price to all the links of the RE tariff, encouraging the grid companies to accept the RE power and so on.

ACKNOWLEDGMENTS

The work described in this paper has been funded by the National Natural Science Foundation of China (Grant No. 71273089) and Beijing Natural Science Foundation of China (Grant No.9122022).

REFERENCES

China Electricity Council. "National Power Industry Statistics Express." In China Electricity Council, edited

by Ministry of Planning and Statistics, 2012.

LI Chen, ZHOU Li-sha, ZENG Ming. "Modeling and Simulation of the Impacts of New Energy Integration on Power Market Based on System Dynamics. "Vol. 10 of East China Electric Power, 2012: 1675-1679.

Long Sheng-ping, Zhang Li-rong, Zhang Fang, et al. "Analysis and Enlightenment of the Western Electricity Regulatory system. "Vol. 7 of Reform & Opening, (2009): 43-44.

South China Bureau of State Electricity Regulatory Commission of China. "South China Electricity Regulatory Practice, Exploration and Thinking. " Beijing: China Electric Power Press, 2012.

Yang Juan. "Electricity price regulation - mode selection and structure design. " Beijing: China Market Press, 2012.